(19) Japanese Patent Office (JP)
(12) **Kokai Unexamined Patent Application Bulletin (A)**

(11)	**Laid Open Patent Application No.**	5-154362
(43)	**Publication Date**	June 22, 1993
	Number of Claims	1
	Number of Pages	4
	Examination Request	Not yet made

(51)	Int. Cl.[5]	Identification Code	Internal File No.	FI	Tech Indic.
	B01D 65/00		8014-4D		
	65/02		8014-4D		
	F04C 2/107		8311-3H		

(21)	**Application No.:**	3-349735
(22)	**Application Date:**	December 10, 1991
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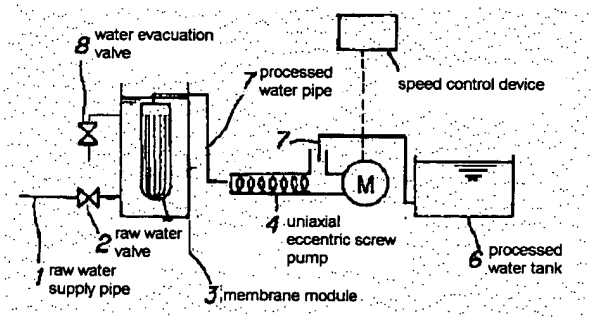
(54) **Title of the Invention:** Membrane Filter Device

(57) **[Abstract]**

[Object] To provide a membrane filter device whereby, using a membrane filter device wherein a membrane module is provided, the equipment is [made] simple and highly efficient filtration and washing are possible.

[Constitution] Using a membrane filter device wherein a membrane module is provided, a positive displacement screw pump serves jointly as a filtration pump and a washing pump.



[CLAIMS]

[Claim 1] In a membrane filter device wherein a membrane module is provided in a tank, the membrane filter device characterized by a system wherein a positive displacement screw pump is used jointly as a filtration pump and a washing pump for said membrane module.

[Detailed Description of the Invention]

[0001]

[Field of Industrial Application] The present invention relates to a membrane filtration device for filtering suspensions contained in raw water such as river water, lake water, human waste water, industrial water and effluent.

[0002]

[Prior Art] The pores of membranes commonly referred to as precision filtration membranes have the diameters from 0.1 μm to several μm. Precision filtration membranes with these pore sizes can be classified into the external-pressure type, for filtering liquid from the exterior of the membrane to the interior thereof, and the internal- pressure type, for conversely filtering liquid from the interior of the membrane to the exterior thereof.

[0003] With external-pressure membrane modules, after continuous filtration for 0.5 to 2 hours, air washing and/or processed-water washing is performed for several minutes from the interior of the membrane to the exterior thereof, using air and/or processed water. Furthermore, with the internal-pressure type membrane modules, washing is performed by flushing with air and/or processed water in the same direction as filtration or in the opposite direction. Generally, at this time, the membrane pressure differential applied to the washing medium that is necessary for filtering is applied by way of pressurization with a pump or by way of suction.

[0004] The general procedure is one wherein membrane filtration is performed, and then processed water washing is performed; but in this case, a pump for feeding raw water and a pump for feeding washing water are necessary. It is also a matter of course that valves must be provided for switching the water feeds. The viscosity of water differs at different temperatures, and even if membrane filtration is performed under identical filtration conditions, such as the same filter-membrane surface area, the same type of filter membrane, or the same filter pressure differential, the flow of processed water produced is not constant, and in order to achieve a constant flow of processed water, the device must include a flow-rate control mechanism.

[0005] If a centrifugal pump, which is the most commonly used, is used for the water feed pump, whether this is used for feeding raw water, or used for feeding washing water when washing, because of differences in the pressure drop across the membrane caused by differences in the degree of soiling of the membrane and water temperature, as described above, the flow of processed water produced and the required washing water flow will vary. In order to maintain these [volumes] constant, flow-rate control mechanisms, such as that of controlling the pump speed or that of providing constant flow valves on the water lines, are necessary.

[0006] Furthermore, in general, the washing water flow necessary for washing external-pressure membrane modules is 1-3 times the processed water flow.

[0007] FIG. 2 shows a flowchart for a system wherein an external-pressure filter membrane is used and raw water is fed to the filter membrane by a pressure pump to produce processed water, and wherein the filter membrane is washed by this processed water, using a washing pump. More specifically, in the drawing, raw water is fed to a membrane module 12, by way of a raw water valve 13, from a raw water supply pipe 11, using a pressure pump 10, and the processed water produced by filtering the raw water is sent from the intake of the membrane module 12 to a processed water tank 17, by way of an outflow valve 15 and a constant flow valve 16 (or a flow-rate control valve), which are provided on a processed water pipe 14.

[0008] When filter resistance rises to a predetermined value as a result of progressive clogging of the filter membrane, the pressure pump 10 is stopped, the outflow valve 15 is closed, the washing valve 19 provided on the washing pipe 18 [leading] from the processed water tank 17 and the water evacuation valve 21 for the membrane module 12 are opened, the washing pump 22 is operated and the membrane module 12 is washed. The required washing water flow is controlled by the constant flow valve 20. Thus, the system shown in FIG. 2 requires the provision of two pumps and six valves.

[0009] FIG. 3 shows a flowchart for a system wherein an external-pressure filter membrane is used and raw water is suctioned to the filter membrane by a suction pump to produce processed water, and wherein the filter membrane is washed by this processed water, using a washing pump. In the drawing, raw water is sent from a raw water supply pipe 31 to a membrane module 32, by way of a raw water valve 33, using a suction pump 30, and processed water produced by filtering the raw water is sent from the intake of the membrane module 32 to a processed water tank 37 by way of an outflow valve 35 and a constant flow valve 36 (or flow-rate control valve), which are provided on a processed water pipe 34.

[0010] When filter resistance rises to a predetermined value as a result of progressive clogging of the filter membrane, the suction pump 30 is stopped, the outflow valve 35 is closed, the washing valve 39 provided on the washing pipe 38 [leading] from the processed water tank 37 and the water evacuation valve 41 on the membrane module 32 are opened, the washing pump 42 is operated, and the membrane module 32 is washed. The required washing water flow is controlled by the constant flow valve 40. Thus, the system shown in FIG. 3 also requires the provision of two pumps and six valves.

[0011]

[Problems to Be Solved by the Invention] The present invention lies in providing a membrane filter device wherein, in a membrane filter device wherein a membrane module is provided in a tank, the processes of filtration by way of the membrane module and washing are performed by a single water pump, and wherein valves other than a raw water valve and a water evacuation valve are not needed, thus allowing realization of simple and efficient filtration and washing.

[0012]

[Means for Solving the Problems] The object described above is achieved by way of, in a membrane filter device wherein at least an external-pressure membrane module is provided, the membrane filter device characterized by a system wherein a positive displacement screw pump is used jointly as a filtration pump and a washing pump for said membrane module.

[0013] Because the positive displacement screw pump used in the present invention is a displacement pump, the flow is constant and the pumping rate can be changed by controlling the speed of the pump. Furthermore, the motor can be reversed, and by reversing the motor the water feed direction can be reversed, while maintaining constant flow characteristics for the pumping rate, meaning that this can be used as both a filter pump and a washing pump. It is particularly preferred that a uniaxial eccentric screw pump be used as the positive displacement screw pump employed in the

present invention.

[0014] The term "membrane filter device wherein a membrane module is provided" generally refers to the use of an internal-pressure membrane module or an external-pressure membrane module as the membrane filter device, the filtration and the washing of the overall membrane filter device being performed by a single positive displacement screw pump.

[0015] When filtering suspensions contained in raw water such as river water, lake water, human waste water, industrial water and effluent, an effective membrane filtration method is to immerse the membrane filter device in tanks of such raw water and subject the raw water to membrane filtration by way of suction; accordingly, suction-type membrane filtration by way of immersing a membrane module in a raw water tank is a preferred mode.

[0016] In terms of the form of the membrane used for an external-pressure membrane module, this may be either a hollow fiber membrane or a ceramic membrane. Furthermore, the membrane filter device may be of the type used by immersion in an open tank, or of the type wherein the membrane is sealed in a closed case, but the type used by immersion in an open tank is preferred. In the case of the type used by immersion in an open tank, it is often convenient for water feed to be performed by way of suction.

[0017] The suction pressure capacity of a uniaxial eccentric screw pump is approximately -8 mAq, and therefore, if a uniaxial eccentric screw pump is used for the present invention, suitable membranes are membranes capable of producing permeate at a membrane pressure differential of no greater than approximately 0.8 kg/cm^2.

[0018] The membrane filter device of the present invention can also be used for sludge processing by way of the activated sludge method; it can be used in place of a sedimentation pond for activated sludge processing and can be such that activated sludge is caused to be present in a processing tank so as to perform biological processing; this can be expected to increase the efficiency of the activated sludge treatment process.

[0019]

[Embodiments] Hereinafter, specific embodiments of the present invention are set forth, but the present invention is not limited thereby. The present invention is described by way of a drawing of a membrane filter device wherein an external-pressure membrane module is immersed in an open tank, as shown in FIG. 1, wherein raw water is fed from a raw water supply pipe 1 to an external-pressure membrane module 3, by way of a raw water valve 2. The raw water is suctioned through the external-pressure membrane module 3 by way of a uniaxial eccentric screw pump 4 and caused to flow into a process tank [*sic*] 6, by way of a processed water pipe 7. The flow rate of the processed water is [controlled] by controlling the speed of a motor for the uniaxial eccentric screw pump 4 by a signal from a pump speed control device.

[0020] When filter resistance rises to a predetermined value as a result of progressive clogging of the filter membrane, washing of the filter membrane with processed water is performed by closing a raw water valve 2, opening a water evacuation valve 9 [*sic*] and running the uniaxial eccentric screw pump 4 in reverse. At this time, the washing water is sent from the processed water tank 6 to the external-pressure membrane module 3, by way of the processed water pipe 7, permeates from the interior of the membrane to the exterior thereof, and is evacuated by way of a water evacuation valve 8. The flow rate of the washing water is also [controlled] by controlling the speed of the motor of the uniaxial eccentric screw pump 4 by a signal from the pump speed control device.

[0021] Because the required washing water flow is 1-3 times the processed water flow, the motor of the uniaxial eccentric screw pump 4 is controlled [so as to run] faster during washing than during filtering.

[0022]

[Effects of the Invention] In the present invention, by combining a positive displacement screw pump and a controller for controlling the speed thereof, filtration and washing are performed using one positive displacement screw pump, thus eliminating one of the two pumps (raw water feed pump and washing water feed pump) that are included in conventional filter devices; furthermore, four valves, including the processed water flow valve, the constant flow valves, and the washing valve, are made unnecessary; the membrane filter device and the processed water tank can be connected by one pipe, by way of the positive displacement screw pump, which results in a device that is much simpler than conventional systems; and maintenance is greatly reduced.

[Brief Description of the Drawings]

[FIG. 1] FIG. 1 is a process flowchart for filtration wherein a membrane filter device having an external-pressure membrane module immersed in an open tank is operated by way of a uniaxial eccentric screw pump and a speed control device therefor.

[FIG. 2] FIG. 2 is a process flowchart of a conventional membrane filter device using a pressure pump and a washing pump, and controlling filtration and washing by way of valves.

[FIG. 3] FIG. 3 is a process flowchart of a conventional membrane filter device using a suction pump and a washing pump, and controlling filtration and washing by way of valves.

[Explanation of the Reference Numerals]

1	raw water supply pipe
2	raw water valve
3	membrane module
4	uniaxial eccentric screw pump
6	processed water tank
7	processed water pipe
8	water evacuation valve
10	pressure pump
11	raw water supply pipe
12	membrane module
13	raw water valve
14	processed water pipe
15	outflow valve
16	constant flow valve
17	processed water tank
18	washing pipe
19	washing valve
20	constant flow valve
21	water evacuation valve
22	washing pump
30	suction pump
31	raw water supply pipe
32	membrane module
33	raw water valve
34	processed water pipe
35	outflow valve
36	constant flow valve
37	processed water tank

38 washing pipe
39 washing valve
40 constant flow valve
41 water evacuation valve
42 washing pump

FIG. 1

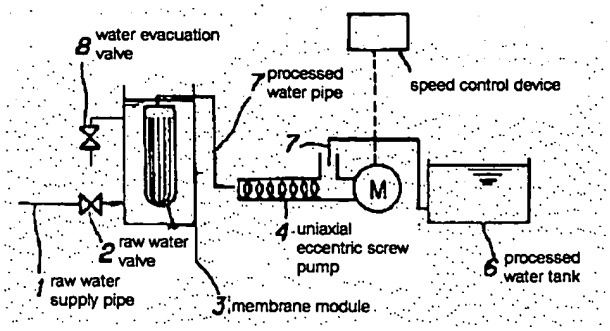


FIG. 2

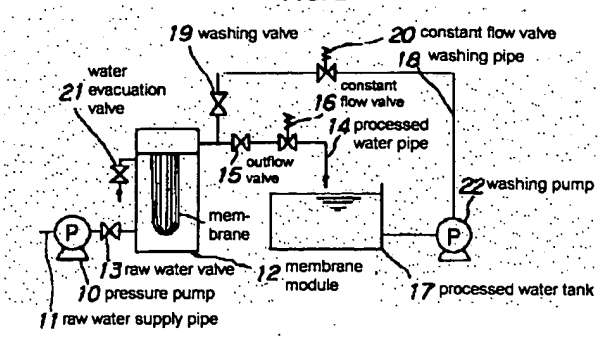
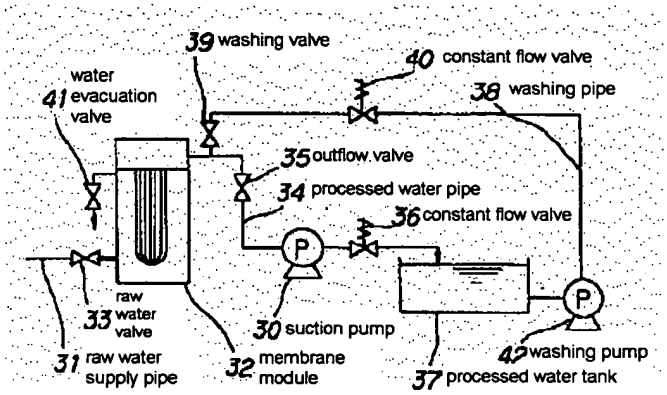


FIG. 3



PATENT ABSTRACTS OF JAPAN

(11)Publication number : 05-154362
(43)Date of publication of application : 22.06.1993

(51)Int.Cl. B01D 65/00
B01D 65/02
F04C 2/107

(21)Application number : 03-349735
(22)Date of filing : 10.12.1991

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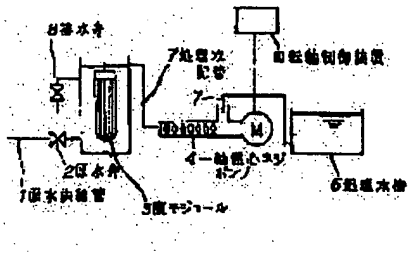
(54) MEMBRANE FILTER

(57)Abstract:
PURPOSE: To easily and efficiently perform the stages of filtration and washing by a membrane module with one set of water supply pump by sharing a positive displacement screw pump with a pump for filtration and a pump for washing of the external pressure type membrane module.
CONSTITUTION: Raw water is introduced into an external pressure type membrane module 3 through a valve 2 for raw water from a supply pipe 1 therefor. In this case, raw water is passed through the membrane module 5 by a uniaxial eccentric screw pump 4, sucked and introduced into a treated water tank 6 through a pipeline 7 for treated water. The rpm of a motor for the pump 4 is controlled by a signal output from a rotary axis controlling device of the pump in accordance with the flow rate of treated water. When blinding of a filtration film proceeds and filtration resistance is raised to the specified value, the valve 2 for raw water is closed and a drainage valve 9 is opened and the motor of the pump 4 is reversely rotated. In such a way, filtration and washing are easily performed by one set of the positive displacement screw pump.



LEGAL STATUS

[Date of request for examination]	12.04.1993
[Date of sending the examiner's decision of rejection]	26.03.1996
[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]	
[Date of final disposal for application]	
[Patent number]	2684483
[Date of registration]	15.08.1997
[Number of appeal against examiner's decision of rejection]	08-06245
[Date of requesting appeal against examiner's decision of rejection]	26.04.1996
[Date of extinction of right]	